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Schuknecht, Ludger; Afonso, António; Tanzi, Vito

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Public Sector Efficiency: Evidence for New EU Member States and Emerging Markets*

António Afonso, [# $] *Ludger Schuknecht* [#] *and Vito Tanzi* [±]

Abstract

In this paper we analyse public sector efficiency in the new member states of the EU compared to that in emerging markets. After a conceptual discussion of expenditure efficiency measurement, we compute efficiency scores and rankings by applying a range of measurement techniques. The study finds that expenditure efficiency across new EU member states is rather diverse especially as compared to the group of top performing emerging markets in Asia. Econometric analysis shows that higher income, civil service competence and education levels as well as the security of property rights seem to facilitate the prevention of inefficiencies in the public sector.

Keywords: government expenditure, efficiency, DEA, new EU member states, emerging markets.

JEL Classification Numbers: C14, H40, H50.

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# European Central Bank, Kaiserstraße 29, D-60311 Frankfurt am Main, Germany, emails: antonio.afonso@ecb.int; ludger.schuknecht@ecb.int.
$ ISEG/TULisbon – Technical University of Lisbon, Department of Economics; UECE – Research Unit on Complexity and Economics, R. Miguel Lupi 20, 1249-078 Lisbon, Portugal, email: aafonso@iseg.utl.pt. UECE is supported by FCT (Fundação para a Ciência e a Tecnologia, Portugal), financed by ERDF and Portuguese funds.
± Inter-American Development Bank, Washington, D. C., email: vitot@msn.com.

1. Introduction

The importance of an efficient use of public resources and high-quality fiscal policies for economic growth and stability and for the well-being of individuals has been brought to the forefront by several developments over recent decades. Macroeconomic constraints limit countries' scope for expenditure increases. The member states of the European Union are bound to fiscal discipline through the Stability and Growth Pact. Globalisation makes capital and taxpayers more mobile and exerts pressure on governments' revenue base. New management and budgeting techniques have been developed and there is more scope for goods and service provision via markets. Transparency of government practices across the globe has increased, raising public pressure to use resources more efficiently (see Tanzi and Schuknecht (2000), Heller (2003), Joumard, Konsgrud, Nam and Price (2004)).

The adequate measurement of public sector efficiency is a difficult empirical issue and the literature on it is rather scarce. The measurement of the costs of public activities, the identification of goals and the assessment of efficiency via appropriate cost and outcome measures of public policies are thorny issues. Academics and economists in international organisations have made some progress in this regard by paying more attention to the costs of public activities via rising marginal tax burdens and by looking at the composition of public expenditure. Moreover, they have been shifting the focus of analysis from the amount of resources used by ministry or programme (inputs) to the services delivered or outcomes achieved (see, for instance, OECD (2003), and Afonso, Schuknecht and Tanzi (2005)).

Our contribution in this study is fourfold: first we discuss and survey conceptual and methodological issues related to the measurement and analysis of public sector efficiency. Second we construct Public Sector Performance and Efficiency composite indicators for the ten (plus two) new member states that adhered to the European Union (EU) on 1 May 2004 (on 2007) as

compared to emerging markets from different regions, and some current EU member countries that show features of emerging markets and/or are undergoing a catching up process. Third we use Data Envelopment Analysis to compute input and output efficiency scores and country rankings, which we combine with a Tobit analysis to see whether exogenous, non-discretionary (and non-fiscal) factors play a role in explaining expenditure inefficiencies. Fourth, we use the information from the Tobit estimations to correct the efficiency scores for the effect of non-discretionary factors. To our knowledge, such an efficiency analysis has not been applied before to this set of countries.

On the second and third objective, the study finds significant differences in expenditure efficiency across new member countries: the Asian newly industrialised economies perform best while the new member states show a very diverse picture. The two-step analysis shows that income, public sector competence and educational levels, as well as the security of property rights, seem to facilitate the prevention of inefficiencies in the public sector, and such factors can be used to correct country efficiency scores.

The paper is organised as follows. In section two we briefly discuss our motivation and review the related literature on public expenditure efficiency. In section three we present the methodologies used for the measurement of public expenditure efficiency. Section four reports stylised facts and our empirical analysis of efficiency via i) performance and efficiency analysis based on cross-country composite indicators, ii) a non-parametric efficiency analysis, and iii) an explanation of inefficiencies via non-discretionary factors. Section five concludes.

2. Motivation and related literature

Economists are concerned about the efficient use of scarce resources. The concept of efficiency finds a prominent place in the study of the spending and taxing activities of governments.

Economists believe that these activities should generate optimal potential benefits for the population and they castigate governments when, in their view, they use public resources inefficiently. International organisations, such as the World Bank and the IMF, often express concern about governmental activities that they consider inefficient or unproductive.

There are many reasons why a society needs public expenditure (and consequently tax revenue). The reasons have been spelled out, over the years, by economists such as Adam Smith, Pigou, Musgrave, Samuelson, and others. Public expenditure is needed to deal with (a) genuine public goods, (b) significant externalities, (c) the creation of social institutions and (d) the rule of law that protect individuals and property. When the focus of public expenditure is on these agreed activities, and is carried out in an efficient manner, the public sector remains small and efficient. Problems arise when (a) public sector activity is carried out beyond the theoretically justified areas; and/or (b) when it is carried out at excessive costs. Of course, the more efficient is the working of the market economy, the smaller should be the scope of activities in which there is even a theoretical justification for public spending (see Tanzi, 2005). Thus, as market economies become more efficient, public spending should fall.

There has been a tendency among economists to measure the output or the benefit in public activities on the basis of the budgeted allocation: the higher the expenditure, the higher the benefit. For example calls to allocate a given, or a larger, share of national budgets to health and education assume such identity between expenditure and benefits. The larger the expenditure, the greater the benefits received by the intended recipients are assumed to be. But, as argued by Tanzi (1974) the two can be widely different. This difference is central to the concept of efficiency.

Additionally, a relevant issue is the distinction between output and outcome. This distinction should be fundamental in the analysis of the efficiency of public spending. There is often much attention paid to the outputs of certain activities and too little to the outcomes. For example the outputs of educational spending may be school enrolments, or number of students completing a grade. The outputs of health expenditure may be the number of operations performed or days spent in a hospital bed. However, the outcomes should be based on how much students learned and how many patients got well enough to return to a productive life.

Some recent papers have used non-parametric approaches for measuring relative expenditure efficiency across countries, notably Data Envelopment Analysis (DEA). This technique, which is applied later in this study, was originally developed and applied to firms that convert inputs into outputs. The term “firm”, sometimes replaced by the more encompassing term “Decision Making Unit” (henceforth DMUs) may include non-profit or public organisations, such as hospitals, universities, local authorities, or countries.

Previous research on the performance and efficiency of the public sector and its functions that applied non-parametric methods found significant inefficiencies in countries. Studies include notably Gupta and Verhoeven (2001) for education and health in Africa, Clements (2002) for education in Europe, St. Aubyn (2003) for education spending in the OECD, Afonso, Schuknecht, and Tanzi (2005) for public sector performance expenditure in the OECD, Afonso and St. Aubyn (2005, 2006) for efficiency in providing health and education in OECD countries. De Borger at al. (1994), De Borger and Kerstens (1996), and Afonso and Fernandes (2006) find evidence of spending inefficiencies for the local government sector. Most studies apply the DEA method while Afonso and St. Aubyn (2006) undertook a two-step DEA/Tobit analysis, in the context of a cross-country analysis of secondary education efficiency.

3. Measuring efficiency in public expenditure: methodologies

3.1. Composite indicators for measuring public sector performance and efficiency

In recent years various attempts have been made at measuring the efficiency of public expenditure via composite indicators. These attempts are of two broad types: macro measurements, and micro measurements. Macro measurements have as their aim an evaluation of public spending in its entirety. In other words they attempt to measure, or rather to get some ideas of, the benefits from higher public spending. When, for example, Sweden spends 1 ½ times as much in terms of GDP shares as Switzerland, what does it get in return? Micro measurements attempt to determine the relationship between spending and benefits in a particular budgetary function or even sub-function (i.e. health spending or the efficiency of spending in hospitals, or spending for protection against malaria, aids, etc.).

A first macro measurement attempt was made by Tanzi and Schuknecht (1997, 2000) in trying to assess the benefits from total public spending in eighteen industrialized countries. The approach attempts to determine whether larger public spending in these industrialized countries provided returns, in terms of some identifiable benefits, that could justify the additional costs (including the reduction in individual economic freedom) associated with higher tax burdens. The key question that it tries to address is whether there is a positive, identifiable relationship between higher public spending and higher social welfare. The application of this method led the authors to conclude that additional public expenditure had not been particularly productive in recent decades. The group of countries with lower levels of public spending had socio-economic indicators that were as good as or at times better than that of the countries with much higher spending levels.

Afonso, Schuknecht, and Tanzi (2005) built composite indicators of public sector performance. They distinguished public sector performance (PSP), defined as the outcome of public policies,

from public sector efficiency, defined as the outcome in relation to the resources employed. This is also the first method we apply in our country sample analysis later in the paper.

Assume that public sector performance (*PSP*) depends on the values of certain economic and social indicators (*I*). If there are *i* countries and *j* areas of government performance which together determine overall performance in country *i*, PSP_i, we can then write

$$PSP_i = \sum_{j=1}^{n} PSP_{ij} \,, \qquad (1)$$

with $PSP_{ij} = f(I_k)$.

Therefore, an improvement in public sector performance depends on an improvement in the values of the relevant socio-economic indicators:

$$\Delta PSP_{ij} = \sum_{i=k}^{n} \frac{\partial f}{\partial I_k} \Delta I_k \,. \qquad (2)$$

The performance indicators are of two kinds: process or opportunity indicators, and traditional or Musgravian indicators. As a first step, they define seven sub-indicators of public performance. The first four look at administrative, education, health and public infrastructure outcomes. Each of these sub-indicators can contain several elements. For example, “administrative” includes indicators for corruption, red tape, quality of judiciary, and the size of the shadow economy. These are averaged to give the value for “administrative” performance. Health includes infant mortality and life expectancy. A good public administration, a healthy and well-educated population, and a sound infrastructure could be considered a prerequisite for a level playing field with well-functioning markets and secure property rights, where the rule of law applies, and opportunities are plenty and in principle accessible to all. These indicators thereby try to reflect the quality of the interaction between fiscal policies and the market process and the influence this has on individual opportunities.

The three other sub-indicators reflect the "Musgravian" tasks for government.[1] These try to measure the outcomes of the interaction with, and reactions to, the market process by government. Income distribution is measured by the first of these indicators. An economic stability indicator illustrates the achievement of the stabilisation objective. The third indicator tries to assess allocative efficiency by economic performance. Once again each of these traditional indicators may be made up of various elements. For example stability is made up of variation in output around a trend and inflation. Finally all sub-indicators are used to compute a composite public sector performance indicator by giving the sub-indicators equal weights. The values are normalized and the average is set equal to one. Then the PSP of each country is related to this average and deviations from this average provide an indication of the public sector performance of each of country.

However, these performances reflect outcomes without taking into account the level of public spending. They ignore the costs in terms of public expenditure. We weigh performance (as measured by the PSP indicators) by the amount of relevant public expenditure that is used to achieve a given performance level. In order to compute these so-called efficiency indicators, public spending was normalised across countries, taking the average value of one for each of the six categories specified above. To get some values of public sector efficiency (PSE) the public sector performance (PSP) is weighted by the public expenditures as follows:

$$PSE_i = \frac{PSP_i}{PEX_i}, \qquad (3)$$

with

1 The conceptual separation between "opportunity" and standard "Musgravian" indicators is of course somewhat artificial as, for example, health and education indicators could also be seen as indicators of allocative efficiency.

$$\frac{PSP_i}{PEX_i} = \sum_{j=1}^{n} \frac{PSP_{ij}}{PEX_{ij}} . \qquad (4)$$

The input measures for opportunity indicators are: public consumption as proxy for input to produce administrative outcomes; health expenditure for health performance/outcome indicators; and education expenditure for education performance. Our earlier study also included a measure of the outcome of public investment, but due to a lack of comparable data, this measure is not used in this study.

Inputs for the standard or "Musgravian indicators" are: transfers and subsidies as proxies for input to affect the income distribution; total spending as proxy for the input to affect economic stabilization (given that larger public sectors are claimed to make economies more stable);[2] and total spending also as a proxy input for economic efficiency and the distortions of taxation needed to finance total expenditure.

However, there are some caveats: it is not easy to accurately identify the effects of public sector spending on outcomes and separate the impact of public spending from other influences. Moreover, comparing expenditure ratios across countries implicitly assumes that production costs for public services are proportionate to GDP per capita.[3]

3.2. Non-parametric analysis of performance and efficiency

The DEA methodology, originating from Farrell's (1957) seminal work and popularised by Charnes, Cooper and Rhodes (1978), assumes the existence of a convex production frontier. The production frontier in the DEA approach is constructed using linear programming methods.[4]

[2] For a differing view on the limits of the stabilising effect of growing government, see Cuaresma, Reitschuler and Sillgoner (2005) and Buti and van den Noord (2003).
[3] See Afonso, Schuknecht, and Tanzi (2005) for a discussion of the several caveats of such approach.
[4] Coelli et al. (1998) and Thanassoulis (2001) offer introductions to DEA, while Simar and Wilson (2003) and Murillo-Zamorano (2004) are good references for an overview of frontier techniques.

Regarding public sector efficiency, the general relationship that we expect to test can be given by the following function for each country *i*:

$$Y_i = f(X_i),\ i=1,\ldots,n \qquad (5)$$

where we have Y_i – a composite indicator reflecting our output measure (the PSP indicator in our case); X_i – spending or other relevant inputs in country i (government spending will be used ahead). If $Y_i < f(x_i)$, it is said that country i exhibits inefficiency. For the observed input level, the actual output is smaller than the best attainable one and inefficiency can then be measured by computing the distance to the theoretical efficiency frontier.

The analytical description of the linear programming problem, in the variable-returns to scale hypothesis, is sketched below for an input-oriented specification. Suppose there are k inputs and m outputs for n DMUs. For the i-th DMU, y_i is the column vector of the outputs and x_i is the column vector of the intputs. We can also define X as the $(k\times n)$ input matrix and Y as the $(m\times n)$ output matrix. The DEA model is then specified with the following mathematical programming problem, for a given i-th DMU, and to be solved for each DMU:[5]

$$\begin{aligned} &Min_{\ \delta,\lambda}\ \delta \\ &\text{s. to} \quad -y_i + Y\lambda \geq 0 \\ &\qquad\quad \delta x_i - X\lambda \geq 0 \\ &\qquad\quad n1'\lambda = 1 \\ &\qquad\quad \lambda \geq 0 \end{aligned} \quad . \qquad (6)$$

In problem (6), δ is a scalar (that satisfies $\delta \leq 1$), more specifically it is the efficiency score that measures technical efficiency. With $\delta<1$, the country is inside the frontier (i.e. it is inefficient), while $\delta=1$ implies that the country is on the frontier (i.e. it is efficient).

[5] We present here the equivalent envelopment form, derived by Charnes et al. (1978), using the duality property of the multiplier form of the original programming model.

The vector λ is a $(n \times 1)$ vector of constants that measures the weights used to compute the location of an inefficient DMU if it were to become efficient. The inefficient DMU would be projected on the production frontier as a linear combination of those weights, related to the peers of the inefficient DMU. $n1$ is a n-dimensional vector of ones. The restriction $n1'\lambda = 1$ imposes convexity of the frontier, accounting for variable returns to scale. Dropping this restriction would amount to admit that returns to scale were constant.

3.3. Using non-discretionary factors to explain inefficiencies

The analysis via composite performance indicators and DEA analysis have assumed tacitly that expenditure efficiency is purely the result of discretionary (policy and spending) inputs. They do not take into account the presence of "environmental" factors, also known as non-discretionary or "exogenous" inputs. However, such factors may play a relevant role in determining heterogeneity across countries and influence performance and efficiency. Exogenous or non-discretionary factors can have an economic and non-economic origin.

As non-discretionary and discretionary factors jointly contribute to country performance and efficiency, there are in the literature several proposals on how to deal with this issue, implying usually the use of two-stage and even three-stage models.[6] Using the DEA output efficiency scores, we will evaluate the importance of non-discretionary factors below in the context of our new member and emerging market sample. We will undertake Tobit regressions by regressing the output efficiency scores, δ_i, on a set of possible non-discretionary inputs, Z, as as follows

$$\delta_i = f(Z_i) + \varepsilon_i \,. \qquad (7)$$

[6] See Ruggiero (2004) and Simar and Wilson (2004) for an overview.

4. A quantitive assessment of public sector performance and expenditure efficiency

4.1. Some stylised facts for the EU new member states and comparative countries

Our country sample includes the ten EU new member states as from 2004 (Cyprus, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Slovak Republic, and Slovenia); the two EU new member states as from 2007 (Bulgaria, and Romania); three "old" member countries that underwent a catching up process after entering the EU, (Greece, Ireland and Portugal); and finally nine countries that can also be considered as emerging markets, (Brazil, Chile, Korea, Mauritius, Mexico, Singapore, South Africa, Thailand, and Turkey). This country selection was determined by the search for a sufficient number of countries which can be compared with the new EU members and for which reasonably good quality data is available so that an expenditure efficiency analysis becomes meaningful. In addition, we will make occasional references to comparative indicators for OECD or EU countries and country averages.

Table 1 illustrates total expenditure and the public expenditure composition across the sample countries, on an average basis for the period 1999-2003 (or within this period according to data availability). First, it is striking that the new EU member countries on average report similar total spending as the "old" EU members and much higher spending than most other emerging markets. When looking for relatively small governments with spending ratios of less than 40% of GDP, we only find the Baltic countries belonging to this group. Second, the divergence in expenditure ratios is enormous ranging from about 18% to 50% of GDP. The Baltics' relatively low spending ratio is about one quarter less than that of the central European countries but it is significantly higher than the average for the Asian emerging economies (Korea, Singapore, and Thailand).

[Insert Table 1 here]

When looking at the expenditure composition, there are further major differences. But these differences are much more pronounced for less productive spending categories. Small government

countries tend to spend equally as much, or even significantly more, on productive spending such as investment and education as the rest of the sample countries. New members report public consumption around 20% of GDP, twice as much as Asian emerging economies, with the reverse relation holding for public investment where new members spend roughly 3% of GDP while the Asian countries report an average above 6% of GDP. Data on transfers and subsidies are sketchier but huge differences are noteworthy: large welfare states of similar size as in the old EU members predominate in many of the new member countries (with the Baltics' featuring somewhat lower expenditure) while such spending in Asian emerging economies is only fractional. When looking at education, differences across country groups are much smaller than for total spending. New members, old EU members and other emerging markets are not far apart from each other. In health, differences are again very significant where central European countries spend almost two and half times as much in % of GDP as the Asian emerging economies.

4.2. Public sector performance and efficiency via composite indicators

4.2.1. Public sector performance (PSP)

As regards public sector performance we have deviated in a few respects from our earlier study. In the absence of reasonable data on public infrastructure we in particular focus on three opportunity indicators and the three respective Musgravian indicators (Annex Tables provide primary data).[7]

We compile performance indicators from the various indices giving an equal weight to each of them and the results are reported in Table 2.[8] The results for public sector performance show

[7] The choice of indicators is slightly different from that used in Afonso, Schuknecht, and Tanzi (2005). In addtion to omitting public infrastructure, education is reflected only by a qualitative measure of education achievement (leaving out secondary school enrolment) and economic performance excludes the level of per-capita GDP (which in this sample would strongly bias in favour of the rich countries).

[8] The relevant time period for the several sub-indicators varies a little according to the availability of data but is essentially reported to 2001/2003 with some variables being used as an average of longer time spans (see the Annex for the precise periods).

some interesting patterns, with an overall very diverse picture for the new EU member states. Starting with the overall PSP indicator, the best performers seem to be Singapore, Cyprus and Ireland. Other Asian emerging economies and Malta follow this group of top performers while most new EU member countries and Portugal and Greece post a broadly average performance. Brazil, Bulgaria and Turkey are placed at the bottom end. The size of government per se appears to be a too crude instrument of differentiation, when looking at the score for large public sector countries.

[Insert Table 2]

When comparing the results for the best performers in this study with those from our earlier study on industrialised OECD countries, it is noteworthy that Ireland was “only” an average performer. Portugal and Greece, which are near average in this group, were amongst the weakest in the former study. The results hence show that public sector performance is on average still somewhat lower in most new EU member countries and emerging markets than in the “old” industrialised countries but a few of them (notably the new member island countries and Asian Emerging economies) have broadly caught up.

With regard to sub-indicators, it is interesting to see that the relatively strong performance of the new EU member states on human capital/education and income distribution contrasts with a relatively weak one for economic performance and stability. There is no clear pattern of distinction between Baltics and Central European countries while the two island countries post strong values for all indicators for which data is available. Asian Emerging economies performed very strongly on administration, human capital and economic stability and growth. Overall performance was very equal as regards health indicators.

4.2.2. Public sector efficiency (PSE)

Public sector performance must be set in relation to the inputs used in order to gauge the efficiency of the state. We compute indicators of Public Sector Efficiency (*PSE*), taking into account the expenditure related to each sub-indicator as described in section three. PSE indicators are presented in Table 3 where, due to data limitations for the pre-1998 period in many countries, averages of the corresponding expenditure item were used for the relatively short period of 1998-2003 (see Annex for precise dates and primary data).

[Insert Table 3]

The results for measuring public sector efficiency show an accentuation of the findings for public sector performance. This suggests that more public spending often has relatively low returns as regards improved performance (which is consistent with the findings of our earlier study for industrialised countries). Most low performers, including most new EU member states range between 0.8 and 0.9 and Cyprus is the only new member country with an average PSE score. Countries with a small government sector post a higher PSE score than the average (and hence even more so than the countries with “big” governments). The emerging countries of Asia plus Mauritius have most of the highest scores as their good performance is achieved with low public spending.

When looking at sub-indices, the new member states efficiency scores are near average on human capital and on income distribution. In all other areas, PSE scores are well below average for the new EU member states. Note also that the income distribution efficiency score is highest in the countries with smaller welfare states. This confirms findings elsewhere that welfare programmes in (rich and) poor countries are often poorly targeted and benefit those with special interests rather than those in need (Alesina (1998) and Schuknecht and Tanzi (2005)).

All in all the results suggest that efficiency differs enormously across countries. In the new member states, a relatively average performance (PSP scores) in most countries is "bought" with too many inputs so that efficiency (PSE) is low. In the next section, we will analyse whether these findings are confirmed by using a DEA approach.

4.3. Relative efficiency analysis via a DEA approach

We used a DEA approach as described above, using as our output measure the PSP composite indicator reported in Table 2 and as an input measure, the total government spending as a ratio of GDP. Table 4 presents both the input and the output oriented efficiency coefficients of the variable returns to scale analysis while the constant returns to scale coefficients are also reported for completeness. We opted for not including Singapore since its economic indicators give it characteristics of an outlier in the country sample we use.[9]

[Insert Table 4]

The results largely confirm the findings of the earlier "macro" approach of determining efficiency of the public sector. New member states are ranked between 9 and 23 on input scores and between 6 and 21 on output scores, hence reflecting rather diverse and often below average efficiency. Two countries that also had amongst the top PSE scores are located on the frontier: Cyprus and Thailand, while Ireland, Korea, Chile and Mauritius come next. From an input oriented perspective, Brazil, Greece and Hungary find themselves at the bottom of the list while most new member states fill the middle ranks. The highest-ranking country uses 1/3 of the input that the bottom ranking one uses to attain a certain PSP score. The average input score of 0.59 hints to the possibility that, for the level of output they are attaining, countries could in theory use around 41 per cent less resources.

[9] Similar overall results are obtained with Singapore, as shown in Afonso et al. (2006).

From an output perspective, the top performer achieves twice as much output as the least efficient country with the same input. The average output score of 0.78 implies that on average, for the level of input they are using, the countries are only obtaining around 78 percent of the output they should deliver if they were deemed efficient.[10] Figure 1 illustrates the production possibility frontier associated with the aforementioned set of DEA results.

[Insert Figure 1]

4.4. Explaining inefficiencies via non-discretionary factors

As an additional step, we extend our analysis to exogenous factors that explain expenditure efficiency (see section three for methodical issues). It is probably reasonable to conjecture that expenditure efficiency depends on the "technology" applied in the public sector, on factors that influence the ability of private agents to protect their resources from public claims, on the monitoring capacities of public and private agents, and on international constraint. The variables and underlying hypotheses we test are the following:

i) Secondary school enrolment. This variable aims to proxy the level of education of the population in a given country. More educated people are hypothesized to be better able to monitor the activities of politicians and bureaucrats and ultimately sanction crass inefficiency. But more education is also likely to imply better educated and trained (and hence more efficient) civil servants.

ii) The competence of the civil servants (survey results presented in the Global Competitiveness Report, see Annex for sources and explanations). This variable aims to measure greater

[10] Such calculations are an approximation of potential direct costs of inefficiency. However, indirect costs, implying a higher loss for consumer welfare should also be taken into account. This is outside the scope of our paper, but Afonso and Gaspar (2007) address this issue.

productivity and efficiency in the public sector through better training etc. It is expected to be correlated with the education variable.

iii) Per capita GDP. This variable aims to proxy the physical capital stock which facilitates an efficient production of public goods and services but which may also facilitate monitoring of policy makers.

iv) An indicator of property rights. Secure property rights make it more difficult for governments to extract wealth/rents from the private sector. They also facilitate holding governments accountable for their actions.

v) Trade openness (exports and imports as a share of GDP). This indicator proxies the degree of international competition over labour and capital that would penalise public inefficiency disproportionately.

vi) Transparency in public policy. This is another indicator that should measure the ease of monitoring public officials.

vii) Other more direct indicators of political accountability (such as civil liberty, political rights or checks and balances) do not show much variation for this country group as almost all of them are in the top group.

Exogenous factors could also include other factors that could be detrimental or favourable to efficiency (such as the climate, the cultural background) for which economically meaningful hypotheses are less readily available. We do not include such variables in our analysis.

Using the DEA output efficiency scores computed in the previous subsection, we now evaluate the importance of non-discretionary inputs via censored Tobit regressions where output efficiency scores are regressed on our choice of exogenous, non-discretionary factors. Table 5 confirms the relevance of several of our hypotheses and the variables chosen to test them.

[Insert Table 5]

The Tobit analysis suggests that the security of property rights, per capita GDP, the competence of civil servants, and the education level of people positively affect expenditure efficiency. Due to significant correlation, however, the two competence/education variables are only significant in separate regressions while the other two variables are robust over all specifications. International trade openness, trust in politicians and transparency of the political system have not been found to display a significant influence on expenditure efficiency (even though only the coefficient for public trust in politicians had the wrong sign). The regressions' standard deviation also points to a reasonable model fit.

In Table 6 we report output efficiency score corrections from model 1 in Table 5 for the environmental variables detected as statistically significant in the Tobit analysis: GDP, property rights, competence of civil servants. We computed these corrections by considering that the non-discretionary factors varied to the sample average in each country. The output scores corrected for environmental effects (truncated to one when necessary) are presented in column five of Table 6 as a result of the sum of the previous four columns. One should also notice that the number of countries considered decreased from twenty-three in the DEA calculations to twenty in the two-step analysis, since property rights, and competence of public civil servants data was not available for Cyprus, Malta, and Thailand.[11]

[Insert Table 6]

Comparing the corrected scores in Table 6, resulting from corrections for environmental variables with the scores from the standard DEA analysis, we can observe some changes. Some countries

[11] We did a similar correction exercise for model 2, where secondary school enrolment is statistically significant, but since the results were not very diferent, this is not reported, being worthwhile noticing that such factor has a positive contribution to the efficiency score of most new EU member states.

decreased their respective distances to the production possibility frontier, for instance this is the case of Hungary, Slovenia, Mauritius and South Africa. In the case of these two last countries, for such improvement contributed positively the above average positioning in terms of property rights, which compensate the negative impact from GDP and competence of civil servants variables. On the other hand, other countries see a decline in their efficiency scores after taking into account the non-discretionary factors. For instance, the aforementioned three factors all contribute negatively to distance away from the frontier Mexico, Romania, and Turkey.

When we compare the results of our composite indicator analysis of performance and efficiency with those of the standard DEA analysis, and the two-step analysis, we notice rather similar results as reflected in very high correlation coefficients for scores and ranks across methods (see Table 7). This is evidence for a certain robustness of our results.

[Insert Table 7]

5. Conclusion

In this paper we analysed public sector efficiency in the new member states of the European Union as compared to emerging markets. We start with a conceptual discussion of expenditure efficiency measurement issues where challenges regarding the measurement of costs, the definition of goals and the measurement of outcomes are significant. Taking these challenges into account, we calculate efficiency scores and rankings by applying a range of measurement techniques to the new EU member countries and a selection of emerging markets, catch-up economies, and EU candidate countries.

The results of our analysis show that expenditure efficiency across new EU member states is rather diverse, especially compared to the group of top performing emerging markets in Asia. From the analysis of composite public sector performance (PSP) and efficiency (PSE) scores we

find that countries with lean public sectors and public expenditure ratios not far from 30% of GDP tend to be most efficient. PSE scores of the most efficient countries are more than twice as high as those of the poorest performers.

From the DEA results we see that a small set of countries define or are very close to the theoretical production possibility frontier: Thailand, Cyprus, Korea, and Ireland. From an input perspective the highest ranking country uses 1/3 of the input that the bottom ranking one uses to attain a certain PSP score. The average input scores suggest that countries could use around 45 per cent less resources to attain the same outcomes if they were fully efficient. Average output scores suggest that countries are only delivering around 2/3 of the output they could deliver if they were on the efficiency frontier.

Finally we examine via Tobit analysis the influence of non-discretionary factors, notably non-fiscal variables, on expenditure efficiency. The study shows that per-capita income, public sector competence and education levels as well as the security of property rights seem to facilitate the prevention of inefficiencies in the public sector. Additionally, we corrected output scores by considering the effects of non-discretionary factors. The country rankings and output scores resulting from such correction, even if not considerably different from the DEA results, allow decomposing the specific non-discretionary factor contribution to the change in the efficiency scores.

From a policy perspective, one should be careful to draw overly strong conclusions and we have referred to a number of caveats in the course of the paper. Nevertheless, it is apparent that many new members states and other emerging markets can still considerably increase the efficiency of public spending by improving the outcomes and by restraining the resource use. The final

econometric analysis also suggests that high education levels, a competent civil service and the security of property rights seem to provide an “extra boost” to public expenditure efficiency.

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Annex – Data and sources

Annex Table A – Primary data for performance sub-indicators

	1/	2/	3/	4/	5/	6/	7/	8/	9/	10/	11/	12/	13/	14/
Brazil	4.6	2.8	3.9	4.6	3.3	68.3	31.0	60.7	1.41	220.9	2.6	7.6	7360	71.3
Bulgaria	5.5	2.5	2.7	5.2	5.0	71.7	14.0	26.4	0.14	139.0	0.7	14.6	6890	87.6
Chile	6.3	3.1	4.6	2.4	3.6	75.8	10.0	56.7	1.43	5.5	4.6	7.9	9190	74.5
Cyprus						78.0	5.0		2.31	3.0	4.0	3.2	21190	88.3
Czech Republic	5.2	2.7	4.2	2.6	5.5	74.9	4.0	25.4	0.97	6.0	2.1	7.0	14720	87.1
Estonia	5.9	4.2	5.3	2.1	5.5	70.6	11.0	37.6	1.26	13.7	4.3	10.6	10170	82.8
Greece	4.8	2.4	4.7	3.5	4.6	78.0	5.0	32.7	3.91	5.4	3.3	10.3	17440	87.4
Hungary	5.8	2.7	4.9	2.3	5.7	71.5	8.0	24.4	2.64	14.2	3.5	7.8	12340	87.2
Ireland	6.0	3.4	5.2	2.3	5.3	76.6	6.0	35.9	2.53	3.1	7.9	7.8	32410	85.8
Korea	5.3	3.2	4.1	2.8	4.7	73.6	5.0	31.6	1.08	4.1	5.4	3.7	15090	90.9
Latvia	4.9	3.7	4.2	3.6	4.8	70.4	17.0	32.4	1.66	10.4	4.7	12.9	7730	74.4
Lithuania	5.5	2.8	3.3	2.4	5.2	72.7	8.0	32.4	0.63	15.4	3.4	8.4	8470	88.6
Malta	6.1	2.9	5.3	3.0	4.9	78.2	5.0		1.47	2.7	3.8	5.2	13160	79.2
Mauritius	4.6	2.2	4.4	3.3	4.2	72.1	17.0		3.26	6.3	4.8	7.3	9860	64.2
Mexico	5.0	2.3	3.3	5.0	3.1	73.4	24.0	53.1	0.70	15.5	2.7	3.1	8430	59.7
Poland	4.8	2.8	3.9	3.7	4.7	73.5	8.0	31.6	2.10	13.2	4.3	13.7	9450	90.9
Portugal	5.8	2.8	5.7	3.0	3.2	75.8	5.0	38.5	1.53	3.3	2.6	5.7	18150	85.2
Romania	3.6	2.0	2.4	5.5	5.9	69.9	19.0	31.1	0.46	58.5	2.1	9.3	5830	79.6
Singapore	6.7	5.1	5.2	1.4	6.5	78.4	3.0	42.5	1.06	1.1	5.1	3.2	22680	74.3
Slovak Republic	5.2	2.2	3.2	1.6	5.6	73.2	8.0	19.5	2.58	8.4	4.2	15.7	11960	74.9
Slovenia	5.8	2.8	4.3	2.0	5.3	75.6	4.0	28.4	3.61	9.7	4.1	7.3	17130	88.6
South Africa	4.9	2.9	5.6	4.5	2.8	47.1	56.0	59.3	2.90	7.3	2.8	25.3	11290	57.2
Thailand	5.1	3.2	4.8	3.7	4.5	69.0	24.0	41.4	0.58	3.6	3.4	3.0	6400	79.8
Turkey	4.1	2.5	3.7	5.7	4.0	69.8	36.0	41.5	0.46	69.8	2.8	7.2	5890	51.3
Average	5.3	2.9	4.3	3.3	4.7	72.4	13.9	37.3	1.7	26.7	3.7	8.7	12635	78.8

1/ Corruption index (1 to 7).
2/ Red tape (burden of regulation) index (1 to 7, good).
3/ Quality of judiciary index (1 to 7, good).
4/ Shadow economy index (1 to 9, bad). We used the following transformation *9-I*, where *I* is the shadow economy index.
5/ Quality of math and science education index.
6/ Life expectancy at birth, years, 2001.
7/ Infant mortality rate (*IMR*), 2001. We used the infant survival rate, *ISR*=(1000-*IMR*)/1000.
8/ Gini coefficient, 2003 or latest year. We used the construction *100-Gini*.
9/ Coefficient of variation (inverse) of average real GDP growth for 1994-2003.
10/ Average inflation, 1994-2003. We used its inverse.
11/ Average GDP real growth rate, 1994-2003.
12/ Average unemployment, 1994-2003.
13/ Per capita GDP, PPP USD, 2001.
14/ Secondary school enrolment ratio, 2001 or latest.

Sources:
1/, 2/, 3/, 4/, 5/ - Global Competitiveness Report, 2003/2004 edition.
6/, 7/, 13/, 14/ - World Bank, WDI 2003.
8/ - World Bank, World Development Report, 2003 edition.
9/, 10/, 11/, 12/ - IMF World Economic Outlook (WEO database).

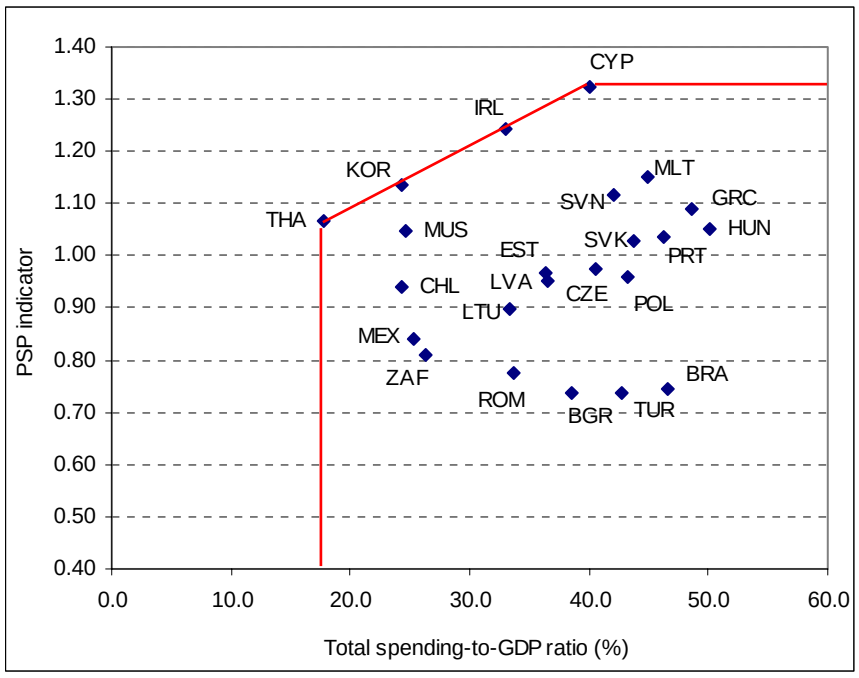
Annex Table B – Primary data for the non-discretionary factors

	GDP per capita 1/	Property rights 2/	Competence of public officials 3/	Secondary school enrolment 4/	Degree of openness 5/	Public trust of politicians 6/	Transparency 7/
Brazil	7360	5.0	2.4	71.3	29.15	2.2	4.51
Bulgaria	6890	3.2	3.3	87.6	116.20	2.3	
Chile	9190	5.6	2.1	74.5	69.15	2.9	6.64
Cyprus	21190			88.3	95.53		
Czech Republic	14720	4.4	2.3	87.1	126.64	1.9	3.60
Estonia	10170	4.8	3.0	82.8	156.22	2.8	5.96
Greece	17440	5.0	1.8	87.4	48.59	2.5	3.45
Hungary	12340	5.3	2.8	87.2	131.49	2.6	3.50
Ireland	32410	6.1	3.6	85.8	151.31	3.2	5.47
Korea	15090	4.7	3.0	90.9	73.51	2.1	4.21
Latvia	7730	4.3	3.1	74.4	97.51	2.3	
Lithuania	8470	4.2	3.4	88.6	109.46	1.9	
Malta	13160			79.2	163.55		
Mauritius	9860	5.4	2.6	64.2	115.24	2.6	
Mexico	8430	4.6	2.6	59.7	57.30	2.5	4.53
Poland	9450	4.6	2.7	90.9	71.28	2.4	2.21
Portugal	18150	5.3	2.2	85.2	66.59	3.2	5.09
Romania	5830	4.5	2.6	79.6	80.38	3.1	3.23
Slovak Republic	11960	5.2	2.0	74.9	156.87	2.8	4.28
Slovenia	17130	4.8	3.4	88.6	112.97	3.0	3.70
South Africa	11290	5.3	1.9	57.2	53.69	2.9	6.05
Thailand	6400		2.6	79.8	124.31	2.8	5.66
Turkey	5890	4.2	2.1	51.3	58.05	1.9	4.43

1/ GDP per capita PPP, 2001, USD.
2/ Financial assets and wealth are (1=poorly delineated and not protected by law, 7=clearly delineated and protected by law), 2001-02.
3/ The competence of personnel in the public sector is (1=lower than the private sector, 7=higher than the private sector).
4/ Secondary school enrolment, 2001 or latest.
5/ Degree of openness = (Imports+Exports)/GDP, 2003.
6/ Public trust in the honesty of politicians is (1=very low, 7=very high)
7/ Transparency, highest is best, 2003 data.

Sources:
1/, 4/ - World Bank, WDI 2003.
2/, 3/, 6/ - World Economic Forum: *Global Competitiveness Report 2001-2002*.
5/ - IMF World Economic Outlook (WEO database).
7/ - IMD World Competitiveness Yearbook 2004.

Figure 1 – Production possibility frontier: one input, one output



BGR – Bulgaria; BRA – Brazil; CHL – Chile; CYP – Cyprus; CZE – Czech Republic; EST – Estonia; GRC – Greece; HUN – Hungary; IRL – Ireland; KOR – Korea; LTU – Lithuania; LVA – Latvia; MEX – Mexico; MLT – Malta; MUS – Mauritius; POL – Poland; PRT – Portugal; ROM – Romania; SVK - Slovak Republic; SVN – Slovenia; THA – Thailand; TUR – Turkey; ZAF – South Africa.

Table 1 – Public expenditure in sample countries and country groups, % of GDP

	Total spending 1/	Government consumption 2/	Transfers and subsidies 3/	Interest payments 4/	Public investment 5/	Education 6/	Health 7/
Brazil	46.6	19.5	17.1	8.2	1.9	4.6	3.3
Bulgaria	38.6	17.3	15.2	3.2	3.4	3.4	4.0
Chile	24.4	12.6	7.9	1.2	2.7	3.8	2.4
Cyprus	40.0	18.0	11.0	3.3	3.0	5.6	2.5
Czech Republic	40.6	22.7	15.0	1.2	3.4	4.0	6.2
Estonia	36.4	19.7	10.7	0.3	4.1	6.2	4.4
Greece	48.6	16.8	17.0	7.2	3.8	3.7	5.1
Hungary	50.2	22.4	15.0	4.6	3.8	4.8	5.3
Ireland	33.0	14.8	9.3	1.7	3.8	4.4	4.9
Korea	24.4	12.7			5.4	3.8	2.4
Latvia	36.6	21.4	12.7	0.9	1.3	5.8	3.5
Lithuania	33.3	20.3	11.1	1.5	2.6	5.9	4.5
Malta	45.0	20.7	14.5	3.8	4.4	4.8	6.2
Mauritius	24.7	12.9		3.8	7.5	3.8	2.1
Mexico	25.3	11.7	5.2	4.6	3.8	4.6	2.6
Poland	43.2	17.9	17.9	2.8	3.3	5.1	4.2
Portugal	46.2	20.7	14.3	3.1	3.7	5.7	6.2
Romania	33.7	15.7	13.7	2.3	1.9	3.4	3.8
Singapore	21.0	11.4	8.7	0.8			1.4
Slovak Republic	43.8	20.0	14.2	3.5	2.9	4.1	5.2
Slovenia	42.1	20.2	18.6	2.3	2.9		6.0
South Africa	26.3	18.4		4.5	2.7	5.7	3.6
Thailand	17.8	11.2			7.7	5.3	2.3
Turkey	42.7	13.8		21.3	4.6	3.5	4.0
Average	36.0	17.2	13.1	3.9	3.7	4.6	4.0
Max	50.2	22.7	18.6	21.3	7.7	6.2	6.2
Min	17.8	11.2	5.2	0.3	1.3	3.4	1.4
New EU members	41.1	20.3	14.1	2.4	3.2	5.2	4.8
Baltic countries	35.4	20.5	11.5	0.9	2.7	6.0	4.1
Other new EU	43.5	20.3	15.2	3.1	3.4	4.7	5.1
Asian NIC	21.0	11.8	8.7	0.8	6.6	4.6	2.0
Other NIC	32.8	15.2	11.8	6.1	3.5	4.1	3.2
OECD 1990s 8/	46.5	19.8	15.1		3.0	5.4	6.2

1/, 2/, 3/, 4/, 5/ - Average for 1999-2003, source: IMF World Economic Outlook, and European Commission AMECO database.
6/ Average for 1998-2001, source: World Bank, WDI 2003.
7/ Average for 1998-2002, source: World Bank, WDI 2003.
8/ Source: Afonso, Schuknecht and Tanzi (2005) for OECD 1990s.
Note: columns 2 through 5 report economic expenditure categories, and that the last two columns report functional expenditure categories.

Table 2 – Public Sector Performance (PSP) indicators (2001/2003)

Country	Opportunity Indicators: Adminis-tration	Human capital	Health	"Musgravian" Indicators: Distribu-tion	Stability	Economic perform.	Total public sector performance (equal weights 1/)
Brazil	0.88	0.80	0.96	0.63	0.43	0.77	0.75
Bulgaria	0.80	1.09	0.99	1.17	0.06	0.31	0.74
Chile	1.12	0.86	1.03	0.69	0.92	1.02	0.94
Cyprus		1.12	1.04		1.59	1.54	1.33
Czech Republic	1.00	1.14	1.02	1.19	0.74	0.74	0.97
Estonia	1.25	1.11	0.99	1.00	0.57	0.88	0.97
Greece	0.95	1.04	1.04	1.07	1.67	0.76	1.09
Hungary	1.09	1.16	1.00	1.21	0.97	0.88	1.05
Ireland	1.17	1.11	1.03	1.02	1.64	1.47	1.24
Korea	1.04	1.08	1.01	1.09	1.00	1.60	1.14
Latvia	1.03	0.98	0.98	1.08	0.76	0.88	0.95
Lithuania	0.98	1.12	1.00	1.08	0.37	0.84	0.90
Malta	1.11	1.03	1.04		1.45	1.12	1.15
Mauritius	0.91	0.86	1.00		1.40	1.08	1.05
Mexico	0.80	0.71	1.00	0.75	0.38	1.41	0.84
Poland	0.92	1.08	1.01	1.09	0.83	0.81	0.96
Portugal	1.11	0.88	1.03	0.98	1.30	0.91	1.04
Romania	0.63	1.13	0.98	1.10	0.18	0.63	0.78
Singapore	1.39	1.16	1.05	0.92	2.94	1.71	1.53
Slovak Republic	0.95	1.07	1.01	1.28	1.09	0.77	1.03
Slovenia	1.07	1.13	1.03	1.14	1.35	0.99	1.12
South Africa	1.00	0.66	0.80	0.65	1.23	0.50	0.81
Thailand	1.03	0.99	0.97	0.93	0.94	1.54	1.07
Turkey	0.77	0.75	0.97	0.93	0.17	0.82	0.74
Average 2/	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Max	1.39	1.16	1.05	1.28	2.94	1.71	1.53
Min	0.63	0.66	0.80	0.63	0.06	0.31	0.74
New EU countries	0.99	1.06	1.00	1.09	0.74	0.86	0.96
Baltics	1.06	1.10	1.02	1.14	0.93	0.95	1.03
Other new EU	0.95	1.05	1.00	1.08	0.66	0.82	0.93
Asian NIC	1.11	1.00	1.00	0.93	1.76	1.44	1.21
Other NIC	0.97	0.91	0.98	0.87	0.96	1.08	0.98

1/ Each sub-indicator contributes 1/6 to total indicator. 2/ Simple averages.

Table 3 – Public sector efficiency (PSE) indicators (2001/2003) 1/

Country	Opportunity Indicators: Adminis-tration	Opportunity Indicators: Human capital	"Musgravian" Indicators: Health	"Musgravian" Indicators: Distribution	"Musgravian" Indicators: Stability	"Musgravian" Indicators: Economic perform.	Total public sector efficiency (equal weights 2/)
Brazil	0.78	0.81	1.15	0.48	0.33	0.59	0.69
Bulgaria	0.79	1.49	1.00	1.01	0.06	0.29	0.77
Chile	1.53	1.04	1.70	1.15	1.37	1.51	1.38
Cyprus		0.92	1.66		1.44	1.39	1.08
Czech Republic	0.76	1.31	0.66	1.04	0.66	0.66	0.85
Estonia	1.09	0.83	0.91	1.21	0.57	0.87	0.91
Greece	0.97	1.32	0.83	0.83	1.23	0.56	0.96
Hungary	0.83	1.12	0.75	1.05	0.70	0.63	0.85
Ireland	1.36	1.18	0.84	1.44	1.79	1.61	1.37
Korea	1.40	1.31	1.72		1.47	2.36	1.65
Latvia	0.82	0.79	1.14	1.11	0.75	0.87	0.91
Lithuania	0.83	0.88	0.90	1.27	0.40	0.90	0.86
Malta	0.92	0.99	0.68		1.16	0.90	0.78
Mauritius	1.21	1.04	1.91		2.04	1.58	1.56
Mexico	1.18	0.72	1.52	1.90	0.55	2.01	1.31
Poland	0.89	0.98	0.97	0.80	0.69	0.68	0.83
Portugal	0.92	0.71	0.66	0.90	1.01	0.71	0.82
Romania	0.69	1.53	1.03	1.05	0.20	0.68	0.86
Singapore	2.09		2.90	1.38	5.05	2.94	2.39
Slovak Republic	0.82	1.23	0.77	1.18	0.90	0.64	0.92
Slovenia	0.91		0.68	0.81	1.15	0.84	0.88
South Africa	0.93	0.54	0.89		1.69	0.68	0.95
Thailand	1.58	0.86	1.68		1.91	3.11	1.83
Turkey	0.96	0.99	0.98		0.15	0.69	0.63
Average 3/	1.06	1.03	1.16	1.03	1.14	1.15	1.09
Max	2.09	1.53	2.90	1.90	5.05	3.11	2.39
Min	0.69	0.54	0.66	0.48	0.06	0.29	0.63
New EU countries	0.87	1.05	0.87	1.04	0.64	0.77	0.84
Baltics	0.86	1.00	0.78	1.16	0.75	0.81	0.83
Other new EU	0.88	1.07	0.91	1.00	0.59	0.76	0.84
Asian NIC	1.63	0.95	2.16	1.38	3.00	2.54	1.93
Other NIC	1.10	0.95	1.32	0.96	1.11	1.29	1.13

1/ These indicators are the expenditure weighted "counterparts" of the indicators of Table 1.
2/ Each sub-indicator contributes equally to the total indicator.
3/ Simple averages.

Table 4 – DEA results: one input, one output

Country	Input oriented		Output oriented	
	VRS TE	Rank	VRS TE	Rank
Brazil	0.381	22	0.562	22
Bulgaria	0.461	15	0.564	21
Chile	0.730	5	0.823	8
Cyprus	1.000	1	1.000	1
Czech Republic	0.439	16	0.735	15
Estonia	0.489	13	0.753	13
Greece	0.407	19	0.822	9
Hungary	0.355	23	0.792	10
Ireland	0.997	3	0.999	3
Korea	0.976	4	0.994	4
Latvia	0.486	14	0.742	14
Lithuania	0.535	10	0.720	18
Malta	0.555	9	0.868	6
Mauritius	0.721	6	0.914	5
Mexico	0.703	7	0.730	16
Poland	0.412	18	0.723	17
Portugal	0.385	21	0.782	11
Romania	0.528	11	0.621	20
Slovak Republic	0.406	20	0.777	12
Slovenia	0.526	12	0.843	7
South Africa	0.676	8	0.693	19
Thailand	1.000	1	1.000	1
Turkey	0.416	17	0.555	23
Average	0.591		0.783	

VRS TE – variable returns to scale technical efficiency.

Table 5 – Censored normal Tobit results
(dependent variable: output efficiency scores from Table 4)

	1	2	3	4	5
Per-capita GDP	7.08E-06 ***	6.68E-06 **	6.75E-06 **	7.08E-06 **	1.33E-05 **
	(2.18)	(2.01)	(2.04)	(2.25)	(2.12)
Property rights	0.102 ***	0.095 ***	0.101 ***	0.127 ***	0.063 *
	(6.57)	(5.07)	(6.60)	(4.54)	(1.76)
Competence of civil service	0.069 ***		0.062 **	0.075 ***	0.109 ***
	(2.80)		(2.12)	(3.06)	(3.02)
Secondary school enrolment		0.003 ***			
		(2.60)			
Trade openness			2.46E-04		
			(0.46)		
Public trust in politicians				-0.055	
				(-1.08)	
Transparency in government					0.010
					(0.42)
$\hat{\sigma}_{\varepsilon}$	0.081	0.086	0.083	0.081	0.083
Nº of observations	20	20	20	20	16

$\hat{\sigma}_{\varepsilon}$ – Estimated standard deviation of ε.

The *z* statistics are in brackets.
*, **, *** - Significant at the 10, 5 and 1 per cent level respectively.

Table 6 – Corrected output efficiency scores (for Model 1)

	DEA scores (1)	GDP correction (2)	Property rights correction (3)	Civil servants correction (4)	Corrected scores (5)=(1)+(2)+(3)+(4)	Corrected Rank
Brazil	0.562	-0.033	0.018	-0.017	0.530	18
Bulgaria	0.564	-0.036	-0.165	0.045	0.408	20
Chile	0.823	-0.020	0.079	-0.037	0.844	6
Czech Republic	0.735	0.019	-0.043	-0.024	0.687	12
Estonia	0.753	-0.013	-0.003	0.024	0.762	10
Greece	0.822	0.039	0.018	-0.058	0.820	8
Hungary	0.792	0.002	0.048	0.011	0.853	5
Ireland	0.999	0.145	0.130	0.066	1.000	1
Korea	0.994	0.022	-0.013	0.024	1.000	1
Latvia	0.742	-0.030	-0.053	0.031	0.690	11
Lithuania	0.720	-0.025	-0.063	0.052	0.684	15
Mauritius	0.914	-0.015	0.058	-0.003	0.954	3
Mexico	0.730	-0.025	-0.023	-0.003	0.679	16
Poland	0.723	-0.018	-0.023	0.004	0.686	13
Portugal	0.782	0.044	0.048	-0.031	0.843	7
Romania	0.621	-0.044	-0.033	-0.003	0.541	17
Slovak Republic	0.777	0.000	0.038	-0.044	0.771	9
Slovenia	0.843	0.036	-0.003	0.052	0.929	4
South Africa	0.693	-0.005	0.048	-0.051	0.685	14
Turkey	0.555	-0.043	-0.063	-0.037	0.411	19
Average	0.757	0.000	0.000	0.000	0.739	

Note: the corrected scores do not always add up to the indicated sum since for the cases were the result was above one it was truncated to the unity.

Table 7 – Comparison of country scores and ranks across methods

	DEA Analyis				Public Sector Efficiency (PSE)		Two-step correction	
Country	Input oriented		Output oriented					
	Score	Rank	Score	Rank	Score	Rank	Score	Rank
Brazil	0.381	22	0.488	22	0.69	23	0.530	18
Bulgaria	0.461	14	0.483	23	0.77	22	0.408	20
Chile	0.73	4	0.615	17	1.38	5	0.844	6
Cyprus	0.489	11	0.867	3	1.08	8	-	-
Czech Republic	0.439	15	0.637	13	0.85	17	0.687	12
Estonia	0.489	12	0.632	14	0.91	12	0.762	10
Greece	0.369	23	0.713	8	0.96	9	0.820	8
Hungary	0.355	24	0.687	9	0.85	17	0.853	5
Ireland	0.576	8	0.813	4	1.37	6	1.000	1
Korea	0.749	3	0.743	6	1.65	3	1.000	1
Latvia	0.486	13	0.624	16	0.91	12	0.690	11
Lithuania	0.535	9	0.588	18	0.86	15	0.684	15
Malta	0.408	19	0.753	5	0.78	21	-	-
Mauritius	0.721	5	0.686	10	1.56	4	0.954	3
Mexico	0.703	6	0.551	19	1.31	7	0.679	16
Poland	0.412	18	0.627	15	0.83	19	0.686	13
Portugal	0.385	21	0.678	11	0.82	20	0.843	7
Romania	0.528	10	0.509	21	0.86	15	0.541	17
Singapore	1	1	1	1	2.39	1	-	-
Slovak Republic	0.406	20	0.674	12	0.92	11	0.771	9
Slovenia	0.431	16	0.731	7	0.88	14	0.929	4
South Africa	0.676	7	0.529	20	0.95	10	0.685	14
Thailand	1	1	1	1	1.83	2	-	-
Turkey	0.416	17	0.482	24	0.63	24	0.411	19
Correlation	Score	Rank	Score	Rank	Score	Rank		
(DEA input, PSE)	0.91	0.77						
(DEA output, PSE)			0.71	0.56				
(DEA output, two-step)			0.92	0.93				
(PSE, two-step)					0.69	0.65		